

THE EDISON-HOPKINSON DYNAMO-ELECTRIC MACHINE

THE following abstract of the report by Mr. Frank S. Sprague on the Edison-Hopkinson dynamo-electric machine will be found of interest to electrical engineers:—

Characteristic features of the dynamo are: General arrangements—those of a shortened and differently proportioned Edison dynamo. The pulley, however, is outside of bearing, and with a face of $6\frac{3}{4}$ inches and diameter of $10\frac{1}{2}$ inches projects $8\frac{1}{4}$ inches outside the base plate. Field coils wound over a 9-inch core with ten layers of No. 16 copper wire (B.W.G.). Two legs in series. Armature: Diameter of core 9 inches, 74 coils, single turn, 8 strands of No. 16 wire, average length 43 inches. Wire bound. Diameter $10\frac{1}{2}$ inches, with $\frac{1}{16}$ inch clearance from pole faces. Zinc plate connecting pole faces; ends of magnets not scraped. Resistances: Field cold, 36.5 ohms; armature cold, .026 ohms. Field measured; armature calculated. Field warm, 37 ohms; armature warm, .0325 ohms. Power supplied from a Lawrence—Armington and Sims—engine, high-speed and non-condensing, driven by a link belt through an Altenek tension belt dynamometer.

Engine diameter $8\frac{1}{2}$ inches accepted.
Stroke $9\frac{1}{8}$ inches measured.
Piston-rod $1\frac{1}{8}$ inch "
Fly-wheel 40 inches "
Indicator spring 56 inches "

1-H.P. = 2 P. L. A. revs.

$$= 2 \cdot \frac{P \cdot 9\frac{1}{8}}{12} \cdot \frac{\pi}{2} (2'425^2 - \frac{1}{4}1^2) \text{ revs.}$$

33'000

$$= \text{Mean pressure} \times \text{rev.} \times .0028107.$$

The magnets were tested by the Poggenorff method.

Total H magnetic field = $Gr \times E \times \frac{\text{position}}{\text{resis.} \times \text{dif.}}$

E = 1'457 Clarke's standard

Gr = 6428

Mean force in laboratory—Westminster:—

			Earth.	No. 45.	No. 17.
May 7	...	...	'121	9'41	11'40
May 8	...	...	'122	9'46	11'45
May 12	...	...	'122	9'40	11'52

Total H field for Manchester:—

E and No. 45 9'55
E and No. 17 11'61

The results of three fairly full loads are given. No. 6 Time, about one hour; load, 192 lamps and ground of about 5 amperes. Lamps not up to candle power.

Potential galvanometer, magnet	...	No. 45	
" " position	...	2	
" " strength	...	9'55	
Average deflection	...	20'79	
Potential at brushes	...	99'27	volts.
Current galvanometer, magnets	...	No. 17	
" " position	...	2	
" " strength	...	11'61	
Average deflection	...	19'39	
Current in lamp circuit	...	112'56	amp.
" field	...	2'68	
" armature	...	115'24	"
Resistance, lamp circuit	...	.882	ohms.
and field	...	.861	"
Total resistance of circuit	...	.8935	"
E.M.F.	...	102'97	volts.
Electrical energy in lamp circuit	...	14'97	H.P.
" field	...	.30	
" armature	...	.58	
Total	...	15'91	H.P.
Dynamometer spring at rest	...	112'23	lb.
" " running free	...	115'00	"
" " load	...	180'11	"
Total difference	...	67'88	"
Above friction	...	65'11	"
Total power to armature	...	17'34	
Power above friction	...	16'63	
Friction	...	71	

Dynamo speed, 1081; engine speed, 289.3; efficiency of conversion, 97.7 per cent.; commercial efficiency, 86.3 per cent.

Dynamo behaved well. Fields cold. Armature moderately warm. Wrist not uncomfortable on coils. Can also be held on commutator. Little sparking.¹ Bearings cool. No increased heating after standing.

The same remarks about the behaviour of the dynamo are pertinent to two later experiments with 192 and 230 lamps respectively. There was no appreciable increase in the heating, and the load could easily have been carried a long while. An increased load of 30 lamps could be carried some time.

Summary of Three Experiments

No.	Time.	Speed.		Current in amperes.			E.M.F. in volts.		Electric H.P. appearing.				H.P. delivered to pulley.		Efficiency.	
		Engine.	Dynamo.	Field.	Lamp circuit.	Total.	Brushes.	Total.	Field.	Armature.	Lamp circuit.	Total.	Absorbed.	Total.	Conversion.	Commercial.
6	1 hour.	289	1081	2'68	112'56	115'24	99'3	103'0	'36	'58	14'97	15'91	16'63	17'34	95'7	86
8	31 min.	309	1157	2'92	123'07	125'99	108'	112'1	'42	'69	17'81	18'92	20'12	20'88	94'0	85
9	1h. 1m.	315½	1179	2'95	144'6	147'55	109'3	114'1	'43	'95	21'18	22'56	23'79	24'56	94'8	86

Means: 94.8%, 86%.

INDIAN METEOROLOGY

I.

EXPERIENCE only confirms what a cursory glance would have led us to anticipate from theoretical and *a priori* considerations—that meteorology, the most modern as well as one of the most ancient of all the sciences, requires to be studied on the largest possible scale. The synoptic charts of the late General Meyer in America, of Hoffmeyer in Germany, and our own Meteorological Office, have graphically and forcibly set before us the variety and complexity of conditions that occur in a horizontal direction, while the observations of balloonists and mountain travellers have equally illustrated the important difference and often complete opposition which exists between the physics of the upper and lower aerial strata. Indeed it may be affirmed of meteorology, with even more truth than of the

analogous science of geology, that it recognises neither political nor superficially physical divisions of the land. When, therefore, we confine our attention to the atmospheric conditions of one small political division of the earth's surface and attempt to deduce from data collected within that region alone the laws which regulate them, we are in a far worse position—especially if we take the British Islands as our example—than if we essayed to construct the science of geology by a like process, since in the latter case, if our horizontal range is limited, these islands form an almost complete and unique epitome of geological stratigraphy. In the case of meteorology, however, it is far otherwise, since our area is not only microscopic in relation to the scale on which meteorological changes occur, but is situated in a peculiarly unfavourable position for studying those changes with success.

¹ Some lateral play of armature and spindle.

In the matter of vertical range we are no less badly off, our loftiest elevation being less than one-fourth of that attainable in some countries.

Fortunately for us, however, we have a dependency which offers rare facilities for the study, not merely of climate and weather, but of what is acknowledged to be the "highest branch of meteorology," viz. *atmospheric physics*.¹

India has, in fact, been often specially alluded to by leading meteorologists as a golden field for this line of research, and Mr. Blanford has with evident pride ventured to predict that, "given a few earnest and intelligent workers, this country [India] will one day play a part second to none in the advancement of rational meteorology."²

The characteristics presented by India, and which have been specially noticed by Blanford, Buchan, and others, are (1) its great size—more than fifteen times that of what we are pleased to call Great Britain; (2) its proximity to the equator; (3) the seclusion of its area by the Himalaya on the north; and (4) the physiological contrasts it presents. If anything further were needed to show the desirability of investigating the meteorology of India, it would be the fact noticed by Prof. Eliot in his "Report" for 1877 (p. 48), that while in Europe the changes of weather take place mainly in a horizontal direction, the homogeneity of those in India over large areas shows that they are rather the result of vertical (expansive and contractive) actions, from which it follows as a necessary corollary that if the dynamics of the atmosphere are ever to be solved, we must combine the facts obtained from regions of vertical with those from regions of horizontal motion, and, as Eliot says, "the two sets of facts must be regarded, not as opposed to, but as *supplementing each other*." Some idea of the work that is being done and the area it represents may be gathered from the fact that according to the "Report on the Meteorology of India for 1880" there are now 121 stations in the Indian area (including Ceylon and Burmah) where meteorological observations are regularly made, together with 385 rain-gauge stations, representing in all an area of 1,131,000 square miles.

This work finds an official outlet in the excellent "Annual Reports" published by Blanford, as well as the valuable monographs on the "Meteorology of Bombay," by Mr. Charles Chambers, F.R.S., and those on the "Bay of Bengal Cyclones," by Prof. J. Eliot, and it will, we venture to think, be admitted by all who have carefully examined these works that they not only reflect great credit on the ability of the writers, but go some considerable way towards indorsing Mr. Blanford's prediction.

Besides these strictly official works, there are published a series of papers entitled the "Indian Meteorological Memoirs," which are intended, according to the preface by Mr. Blanford, as "a vehicle for the publication of such portions of the work of the officers of the Indian Meteorological Department as do not form part of the regular Annual Reports on the Meteorology of India."

In the present articles we purpose noticing briefly the first complete volume of these. Before doing so, however, we may observe that their quality is uniformly of a remarkably high order. We know of nothing approaching to them in this country in meteorology, except, perhaps, occasional papers in the *Transactions and Proceedings of the Royal Society*, or a few publications of the Meteorological Council; and we have to go abroad, to the *Repertorium of Russia*, or the *Zeitschrift of Austria*, before we can find papers of equal calibre. This defect is unfortunately more readily explained than remedied. In this country our best men, for reasons which are many of them obvious, and which we need not dwell upon, devote themselves to almost any other science but meteorology. The consequence is that little is done, and that little often indifferently, thus in some measure justifying the scorn which many physicists openly entertain for the science and all its disciples. Before, however, these gentlemen pledge themselves to their verdict, let them look abroad to America, Russia, and India, where more interest is taken in the science, and where the field of operations is vastly more extensive, and the conditions more favourable, and we suspect they will be inclined to modify their views somewhat, and allow that after all this useful and still growing science can not only borrow from their laboratories, but repay with interest, and that it offers a more divergent scope than is often imagined for discoveries tending to throw light on some of the most intricate problems of physics.

¹ Vide "Elementary Meteorology," by R. H. Scott, F.R.S., 1883, p. 4.

² "Vade Mecum," p. 3.

Vol. I. of these "Memoirs" comprises twelve papers, the first of which is dated December 8, 1876, and the last October, 1881, which we will now proceed to examine seriatim.

Paper I. "The Winds of Calcutta," by H. F. Blanford, F.R.S.

This paper represents an analysis of ten years' hourly observations of the wind vane, and four years' anemograms. One of the first things we notice is that while the annual resultant, calculated by Lambert's formula, which takes no account of variation of velocity but assigns an equal value to all observations, is south 14° west, that derived from the four years' anemograms, where the true resultants enter, is south 18° east, the difference being caused by the greater frequency and less velocity of west than east winds at Calcutta. Another interesting conclusion deducible from the annual figures is that the velocity of the Bay of Bengal (south-east) branch of the monsoons current is considerably less than that of the Bombay, or as it is called Arabian Sea (south-west) branch of the monsoon. This fact was previously noticed by Mr. Blanford in his paper on the "Winds of Northern India,"¹ and receives further confirmation from a comparison of wind-velocities at representative stations in the Bombay and Bengal Presidencies in recent reports. Thus in that for 1877 Prof. Eliot gives the following comparison of velocities for representative stations in August, on opposite sides of the Peninsula:—

Bombay.		Bengal.	
	Average daily wind velocity —August.		Average daily wind velocity —August.
Kurrachee ...	497'8	Sangor Island ...	251'0
Bombay ...	408'3	Calcutta ...	123'4
Belgaum ...	213'3	Chittagong ...	151'4
Bangalore ...	219'0	Dacca ...	147'9
Akola ...	189'5	Patna ...	80'4
Nagpur ...	131'9	Allahabad ...	91'6
Jubbulpore ...	127'5	Roorkee ...	65'5

Prof. Eliot ascribes this defect in velocity of the Bengal branch of the monsoon to the deflection it undergoes by impinging upon the Arakan and Himalayan ranges.

And doubtless this expresses a portion of the truth. It ignores, however (explicitly at least), a circumstance which we think has a good deal to do with the result, viz. the fact that this deflection acts so as to continually rob the current of its *easterly component*, due to the change of latitude, and *which, in consequence of its northerly direction, tends to be continually reproduced*. In consequence of this, the current, instead of rebounding from the Arakan hills once for all, tends to hug the mountains all round the northern borders of Assam, and consequently loses a good deal of its velocity by the friction thus engendered. The importance of this south-east branch of the monsoon current cannot be over-estimated. It depends evidently for its existence on the presence of the Bay of Bengal, so that, were the latter area land instead of water, the now moist and fertile districts of Assam and Bengal would probably be arid wastes like the deserts of Scinde and Rajputana.

In discussing the diurnal variation in the direction and velocity of the wind, Mr. Blanford alludes to Mr. Chambers' discovery of the relation between the double diurnal variation in the wind components and the critical points in the diurnal barometric tide.

M. Rykatcheff not long ago, on the basis of the diurnal variation of the east and west components of the wind, laid the foundations of a most ingenious theory of the cause of the diurnal variation of the barometer.² Detailed reference to it here would be out of place, but it may be observed that the fact of the easterly components prevailing at the time of diurnal rise and the westerly at the time of the fall of the barometer, both at Calcutta and Bombay, accords with the daylight conditions at all the stations cited by Rykatcheff, as well as with the view that the air near the surface flows out from the 10 a.m. wave of high pressure, both in its advance from the east and its retreat towards the west.

The explanations of the diurnal oscillation of the barometer, propounded by Rykatcheff and Chambers, while they coincide in attributing it to the proximate influence of the analogous diurnal variation in the velocity and direction of the wind, differ from each other essentially in one or two points. Thus Rykatcheff leaves the north and south components out of account

¹ *Phil. Trans.*, vol. clxiv. part ii., pp. 563-653.

² "La Marche Diurne du Baromètre en Russie et quelques Remarques concernant ce Phénomène en général." *Rep. für Met.*, 1879.

altogether, and only takes the east and west components into consideration. Mr. Chambers, on the other hand, while attaching considerable importance to the meridional components, except very near the Poles, omits curiously enough all reference to the probable corresponding variations in the upper currents of the atmosphere, upon which Rykatcheff discourses most effectively. Each theory alone is defective; a combination of the two would probably form a fairly satisfactory explanation of a considerable part of the diurnal variation, though it will be safer at present to conclude that, while there is a very intimate relation between the diurnal variation of the wind and the barometric tides, we do not as yet know for certain whether either is the cause of the other or whether both are not effects of some common cause.¹

Mr. Blanford discusses the diurnal variation of the wind at Calcutta through the medium of Bessel's interpolation formula, and by comparing similar terms in the wind and barometric equations deduces several interesting results. Thus the single (semicircular) oscillation of the north and south components, is found to represent in all probability the diurnal land and sea breeze, while the single oscillation of the east component coincides in direction and phase with the rise and fall of the day land wind from the interior of the continent.²

Dealing in like manner with the double (quadrantal) terms, it is shown that the variations of both the north and south components and east and west components is very similar to that of the second term in the barometric fluctuation, though the course of the north and south components is exactly the reverse in direction of those at Bombay.

In part ii. of this paper the thermal, baric, and hyetic wind-roses are discussed. The results may be briefly summed up as follows:—(1) that polar currents play no part in the wind system of Bengal, which indeed might have been anticipated, owing to the presence of the Himalayan barrier to the north isolating India in so unique a manner from extra-tropical influences; (2) that rain is most probable, not when the monsoon current is blowing steadily, but "when it is deflected from its normal direction by some local irregularity of pressure," in other words, when *small* depressions prevail, and in this respect it would seem that the law is one of general incidence; (3) that when the periodic components are eliminated there is no definite relation between the non-periodic variations of pressure and those of temperature and humidity. This result is just what we should expect from a local application of the statistical method, now we know, thanks to the recent development of the synoptic method, that the larger oscillations of pressure which accompany the passage of cyclones and anticyclones, are due to conditions which are in operation over regions widely removed from those where such oscillations prevail. This conclusion, moreover, so far as India is concerned, derives fresh support of late from the fact that certain abnormal features in the pressure over India and adjoining countries during the droughts and famines in Madras and the North-West Provinces in 1876-77 were due to some widespread influence which mainly affected the atmosphere *above* the level of the Himalayan sanatoria (7000 feet), since the variations in the density of the atmospheric stratum *below* this level were not only opposite to those at the higher levels, but to those which prevailed in the total pressures at the lower stations throughout the Peninsula.

Paper II. "The Meteorology and Climate of Yarkand and Kashgar."—This is a discussion chiefly of the registers kept by Dr. Scully, of the Bengal Medical Service, who, in the autumn of 1874, accompanied the mission sent by the Indian Government to Kashgaria under the charge of Mr. R. B. Shaw. The observations were carefully made, and as they represent a district whose meteorology had hitherto been entirely unknown, and of which we can only get samples by the aid of such rare opportunities as political embassies, their discussion is well worth the labour which Mr. Blanford has bestowed upon it.

Where it was possible, on the route, and at Yarkand and Kashgar on four days in each month, horary observations were made.

Some evidence of the laborious nature of the task to which Dr. Scully so nobly devoted himself may be gathered from the fact that in order to get a second observer he was obliged to teach an uneducated hill coolie named Bhola, first the use of

English numerals, then decimal fractions, and finally the mode of reading and recording the various instruments in the newly-acquired notation.

Any one who knows the amount of intelligence evinced by the ordinary Indian coolie, will agree with Mr. Blanford in his remark that "it was an achievement which reflected the highest credit on both teacher and pupil."

From the geographical description of the country which accompanies Dr. Scully's report, we gather that the soil is very arid, the rivers are chiefly snow-fed, and that there are deposits of *loess*, similar in all respects to that of the Rhine and the Danube. By many, this loess is inferred to be of subaerial origin, and the peculiar dust-haze which prevails in these regions, is cited in favour of this idea.¹

The chief points noticed in this paper are: (1) the excessive dryness of the climate and consequent large amplitude of the diurnal temperature oscillation; (2) the abnormally large annual range of barometric pressure; and (3) the fact that the non-periodic oscillations of barometric pressure at Yarkand, unlike those of stations situated to the south of the Kuen-Lun, Karakoram, and Himalaya ranges, appear to have some sort of connection with those of Europe. Such large oscillations are in fact probably confined to the lower and denser portion of the atmosphere, which is effectually partitioned off from the north by ranges of such lofty elevation.

The latter part of the paper deals with the diurnal periodic oscillations in the pressure, vapour tension, and winds, and it may be observed that, in regard to the first of these, Yarkand is found to exceed in range any other place under an equally high latitude. Even in winter it averages 0.07 inches between 10 a.m. and 4 p.m., while in June and July it is 0.098 inches between the same hours.

In other respects the curve is characteristically continental, the fall of the night tide being almost evanescent.

The diurnal variation of the wind at Yarkand also presents a peculiarity worthy of remark, in that, as at Zikawei, in China, and Upsala, in Sweden, it violates the general rule that easterly components prevail in the morning and westerly in the afternoon. Like the sea in these places, the desert stretches to the east of Yarkand, and there is every reason to suppose that something analogous to a sea-coast system of local convection currents exists which overrides the normal right-handed rotation of the diurnal breeze.

(To be continued.)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

THE Gilchrist Engineering Entrance Scholarship at University College, London, will be open to competition at the end of September. The conditions of examination are this year somewhat altered in a direction which places the scholarship better within the reach of those for whose benefit it was founded. The detailed regulations can be obtained on application to the secretary of University College; the following is a summary of them:—Candidates must be under nineteen years of age, and must send in notice to compete by September 23. The subjects of examination are (1) elementary mathematics, and (2) any two or more of the following five subjects: mechanics, mechanical drawing, essay on one of three given subjects connected with mechanics or engineering, French or German, the use of tools, either carpenters' tools, or the lathe (wood or metal), or the file. The Scholarship is of the value of 35*l.* per annum, and is tenable for two years. There is also at University College a Senior Engineering Scholarship, awarded at the close of the session, of the value of 80*l.* The regulations affecting this scholarship, as well as those of the Andrews Entrance Prizes, &c., can be obtained on application to the Secretary.

UNIVERSITY COLLEGE, Dundee, has already issued its first Calendar, necessarily a thin one, but bound to increase in size. So far as the science classes are concerned, and these are the prominent features in the College, the arrangements are fairly

¹ Richthofen, in his work on China, similarly attributes the enormously thick formations of *loess* in the northern part of that country, to the action of the winds. It seems reasonable, however, to imagine that, like the analogous European deposits, it might have been originally deposited as Pleistocene glacial unstratified mud from the neighbouring Thian-Shan and Kuen-Lun ranges, and that it has since been redistributed and perhaps in part augmented, by æolian action. The fact that it occurs in North China, and not South China, and that traces of the Glacial period extend as far south as the Himalaya, favours this supposition.

¹ A full account of Mr. Chambers' theory is given in the *Philosophical Transactions*, 1873, and in the *Proc. Roy. Soc.*, xxv., p. 402.

² This wind is called an anti-convection current, as will subsequently be seen in our notice of a paper by Mr. Chambers on "The Winds of Kurrahee."